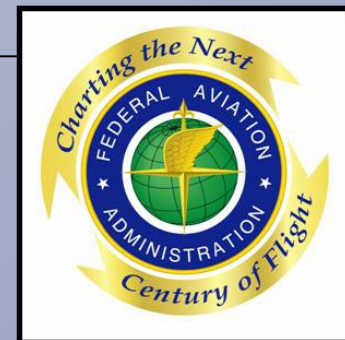


The Birdstrike Identification Program at The Smithsonian Institution

Carla J. Dove, Ph.D.

Division of Birds, National Museum of Natural History
Washington, DC



"BIRDSTRIKE

IDENTIFICATION"

Each year bird-aircraft collisions (birdstrikes) cause an average of \$44 M in damages to US Air Force, and \$600 M in damages to US civil aircraft.



T-38 - *White-tailed Hawk*



American Airlines - *Canada Goose*



Experimental Aircraft - *Lesser Scaup*



T-38 - *Great Egret*



Top USAF Birdstrikes Strikes by Cost

Current as of 1 Jan 2007

Common Name	Cost	Count	Cost per 100K Flying Hours
American White Pelican	\$257,628,460.00	18	\$444,527.78
Canada Goose	\$92,328,526.00	129	\$159,309.24
Black Vulture	\$54,355,588.00	403	\$93,788.43
Turkey Vulture	\$51,708,040.00	776	\$89,220.19
Spot-billed Duck	\$24,920,198.00	13	\$42,998.82
Red-tailed Hawk	\$13,353,102.00	781	\$23,354,.29
Barn Swallow/Swallow	\$11,272,852.00	1745	\$19,450.86
Dark-eyed Junco	\$10,043,181.00	100	\$17,329,11
American Mourning Dove	\$9,520,849.00	2497	\$16,427.85
Snow Goose	\$6,317,841.00	73	\$86,545.77
Horned Lark	\$5,760,469.00	2989	\$9,939.49

2007 How Much Damage Can A Bird 2007 Cause?



\$7,176/strike (\$7,176/1)



\$547/strike



\$32,258/strike (\$1M/31)



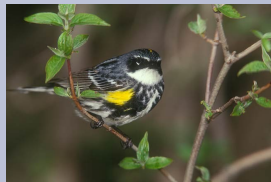
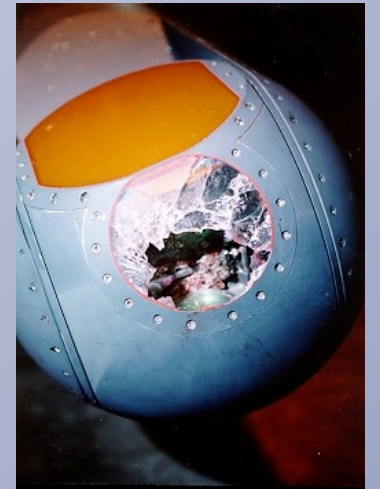
*\$2,042/strike
(\$335,000/164)*

Benefits of species

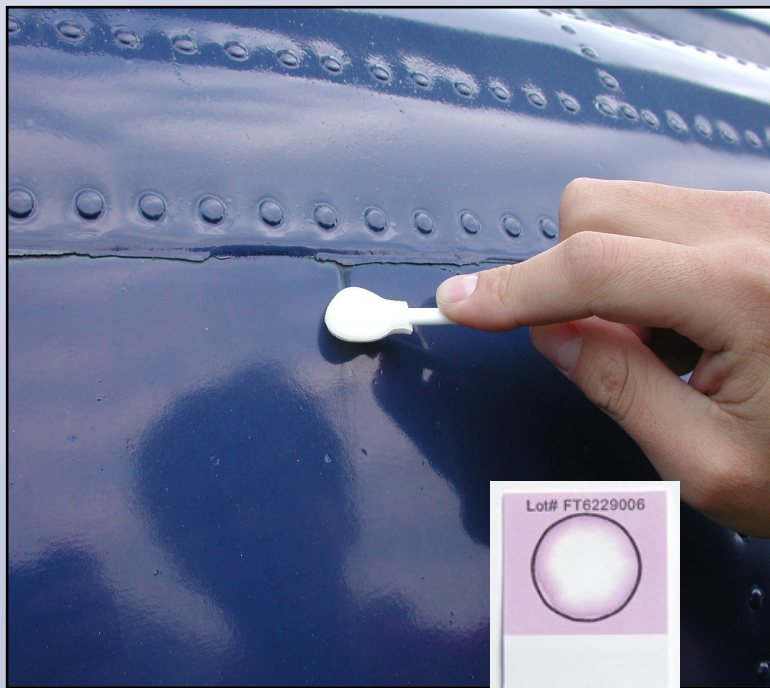
identification data:

Developed for bird tolerant aircraft
windshields and engines based on weights of birds

- USAF F-16 cockpit redesigned to lower pilot's seating position to avoid injury from break-away debris
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- Data used to justify construction of landfills away from airfields
- Habitat management plans implemented to discourage bird use on airfields
- Pest Management/bird control on airfields
- USFWS depredation permits
- Information on migration, habitat preference, diet, life history







FEATHER IDENTIFICATION - Whole Feathers

**50% OF THE
BIRDSRIKE SAMPLES
ARE IDENTIFIED
USING
CHARACTERISTICS
OF WHOLE
FEATHERS**

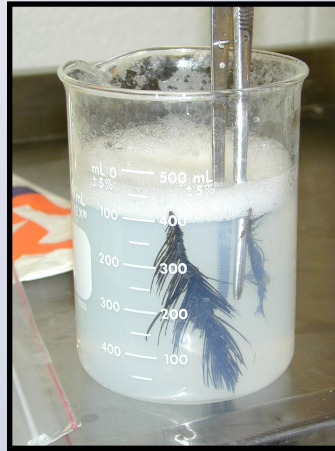
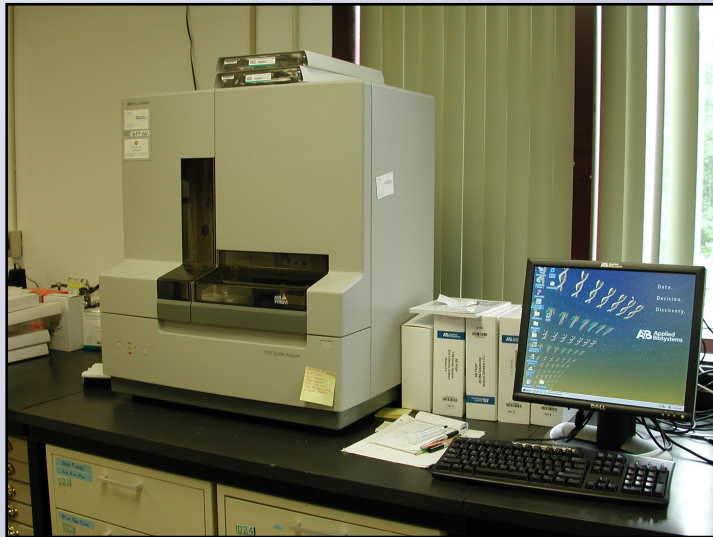
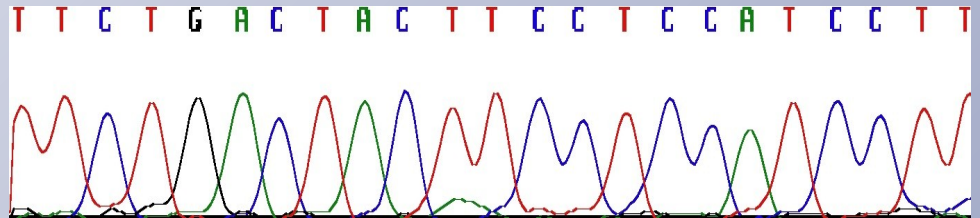
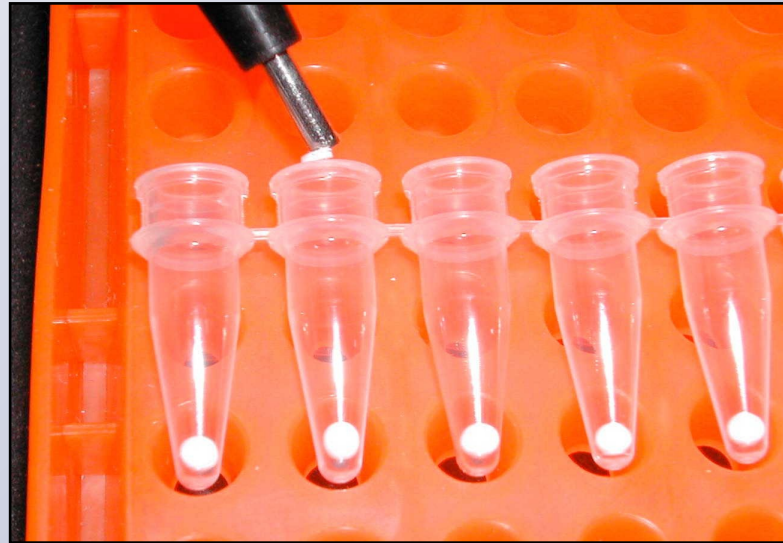


Photo: Chip Clark

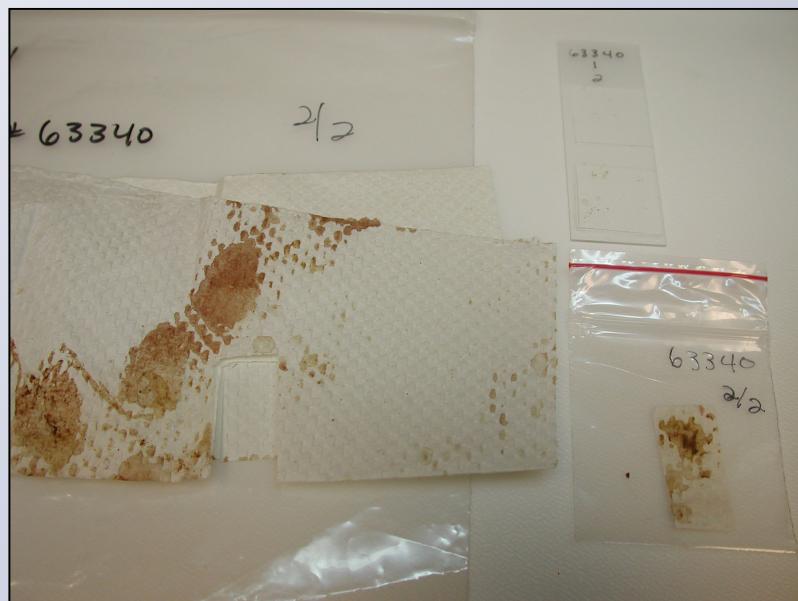




FEATHER IDENTIFICATION -DNA Analysis







BARCODE OF LIFE DATA SYSTEMS

Advancing species identification and discovery through the analysis of short, standardized gene regions

SEARCH

About BOLD Contact Us



Published Projects | Identify Specimen | Request an Account | Introductory Tutorial | Documentation | Citation

The Barcode of Life Data Systems (BOLD) is an online workbench that aids collection, management, analysis, and use of DNA barcodes. It consists of 3 components (MAS, IDS, and ECS) that each address the needs of various groups in the barcoding community.



MANAGEMENT & ANALYSIS

BOLD-MAS provides a repository for barcode records coupled with analytical tools. It serves as an online workbench for the DNA barcode community.

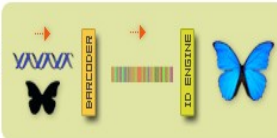
Username
Password

[Request a new user account](#)



IDENTIFICATION ENGINE

BOLD-IDS provides a species identification tool that accepts DNA sequences from the barcode region and returns a taxonomic assignment to the species level when possible.



EXTERNAL CONNECTIVITY

BOLD-ECS provides web developers and bioinformaticians the ability to build tools and workflows that can be integrated with the BOLD framework. We welcome the addition of new analytical modules.



BARCODE COUNTS

Species Barcoded	24,937
Total Barcode Records	191,123
Source	Breakdown
GenBank	41,451
Canadian Centre	143,263
Others	6,409

SYSTEM UPDATES

Aug-1-2006 - Tree Export to Newick (MAS)

The Taxon ID Tree module now provides an export function allowing users to download trees in Newick Format. A Newick formatted tree can be opened in variety of tree manipulation and rendering programs.

Jul-19-2006 - Specimen Age vs Sequence Length (MAS)

This new analytical module supports investigation of DNA degradation over time by determining the correlation between sequence length and specimen age.

Jul-13-2006 - Search Upgrade (MAS)

The search tool now supports searches by species epithet or sequence length.

Jul-02-2006 - Trace File Viewer Upgrade (MAS)

The trace file viewer now reports the quality of each trace file (failure, low, medium, high) quality based on QV/PHRED scores.

Jul-02-2006 - Trace File Download (MAS)

Trace Files can be downloaded from the Project Console or from each sequence page.

Jun-29-2006 - High Resolution Maps (MAS)

High resolution maps are now generated for collection sites using Google Maps. Each map provides hot links to the specimens collected at a specific site.

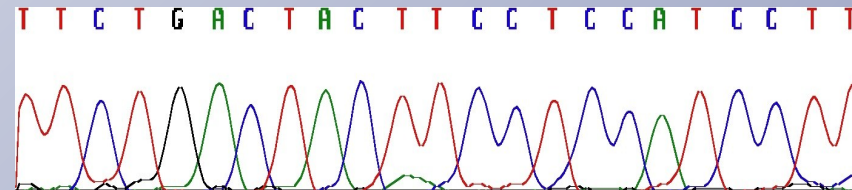
Jun-2-2006 - Reference Barcodes (IDS)

The ID system now provides the option of gaining identifications based on either a validated reference dataset or the full data set.

BARCODING CAMPAIGNS



Photo courtesy Biodiversity Institute of Ontario



A DNA “barcode” is a 648 bp portion of a gene called cytochrome c oxidase subunit 1 (CO1) that has been selected as a standardized region for species identification

**BOLD - ID**

The BOLD Identification System (IDS) accepts sequences from the 5' region of the mitochondrial gene COI and returns a species-level identification when one is possible. Further validation with independent genetic markers will be desirable in some forensic applications.

The reference database of validated records is used by default and is recommended for all identification purposes.

Search Database:

- ☐ **All Available Barcode Records (165,048 Sequences/19,163 Species)**
Full database of barcode records (warning: unvalidated dataset). This includes many species represented by only one or two specimens as well as all species with interim taxonomy.
- ☒ **Reference Barcode Database (59,885 Sequences/6,476 Species)**
Validated subset of the full database containing only those species represented by three or more individuals showing less than 2% sequence divergence

Enter sequences in fasta format:

```
attggcacagcactcagcctgctaac  
cgcgctgaactaggccagcaggaaccctcctaggtgatgaccaaatttataacgtaac  
gtcaccgcccacgcctttgtaataatcttctcatggtgatacccatcataattggagga  
ttcggcaactgattagtcctcctaataattggcgccccgacatggcattcccacgaata  
aacaacataagctttgactcctccaccctcattccttctactactcgccctcatctacc  
gtagaagccggcgccggtacaggctgaaccgtgtaccacccctagcgggcaacctggcc  
catgctggggcttcagtgagcctagccatcttctccctccacttgccgggtatttctcc  
atcctcggggccattaatttcactacgagccatcaacataaaacccccgcacttca  
caatacacaaccccgcttttgcgtgatctgtcctaattaccgctatcctgctcctctg  
tccttcccgctccttgctgcccgcattacaatgctactaacggaccgaaaccaaacc  
acattttcgatcccgcgtggagg|
```

Submit

Cancel



Specimen Identification Request

Search Request:

Type : Reference Database Search

Search Result:

Identification Summary :

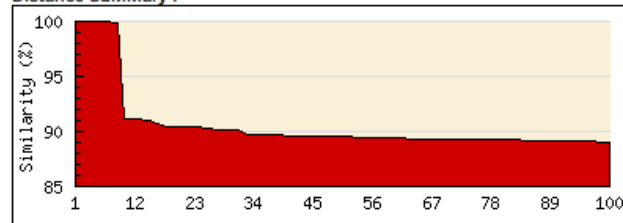
Taxonomic Level	Taxon Assignment	Probability of Placement (%)
Phylum	Chordata	100
Class	Aves	100
Order	Anseriformes	100
Family	Anatidae	100
Genus	<i>Aix</i>	100
Species	<i>Aix sponsa</i>	100

A species level match has been made. This identification is solid unless there is a very closely allied congeneric species that has not yet been analyzed. Such cases are rare.

Tree Based Identification

Species Page

Distance Summary :



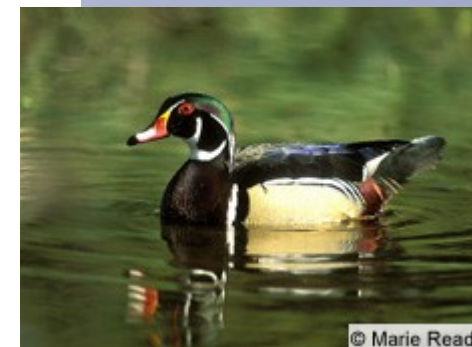
Similarity scores of the top 100 matches

TOP 20 Matches :

Display option: default

Phylum	Class	Order	Family	Genus	Species	Specimen Similarity (%)
Chordata	Aves	Anseriformes	Anatidae	<i>Aix</i>	<i>sponsa</i>	100
Chordata	Aves	Anseriformes	Anatidae	<i>Aix</i>	<i>sponsa</i>	100
Chordata	Aves	Anseriformes	Anatidae	<i>Aix</i>	<i>sponsa</i>	100
Chordata	Aves	Anseriformes	Anatidae	<i>Aix</i>	<i>sponsa</i>	100
Chordata	Aves	Anseriformes	Anatidae	<i>Aix</i>	<i>sponsa</i>	100
Chordata	Aves	Anseriformes	Anatidae	<i>Aix</i>	<i>sponsa</i>	100
Chordata	Aves	Anseriformes	Anatidae	<i>Aix</i>	<i>sponsa</i>	100
Chordata	Aves	Anseriformes	Anatidae	<i>Aix</i>	<i>sponsa</i>	99.83
Chordata	Aves	Anseriformes	Anatidae	<i>Aix</i>	<i>sponsa</i>	99.83
Chordata	Aves	Anseriformes	Anatidae	<i>Melanitta</i>	<i>nigra</i>	91.16
Chordata	Aves	Anseriformes	Anatidae	<i>Melanitta</i>	<i>nigra</i>	91.16
Chordata	Aves	Anseriformes	Anatidae	<i>Melanitta</i>	<i>nigra</i>	91.16
Chordata	Aves	Anseriformes	Anatidae	<i>Melanitta</i>	<i>nigra</i>	91.13
Chordata	Aves	Anseriformes	Anatidae	<i>Melanitta</i>	<i>nigra</i>	91.07
Chordata	Aves	Anseriformes	Anatidae	<i>Melanitta</i>	<i>nigra</i>	90.98
Chordata	Aves	Anseriformes	Anatidae	<i>Melanitta</i>	<i>nigra</i>	90.77
Chordata	Aves	Anseriformes	Anatidae	<i>Bucephala</i>	<i>islandica</i>	90.58
Chordata	Aves	Anseriformes	Anatidae	<i>Bucephala</i>	<i>islandica</i>	90.4
Chordata	Aves	Anseriformes	Anatidae	<i>Bucephala</i>	<i>islandica</i>	90.4
Chordata	Aves	Anseriformes	Anatidae	<i>Bucephala</i>	<i>islandica</i>	90.4

100% match
to Wood Duck
(*Aix sponsa*)

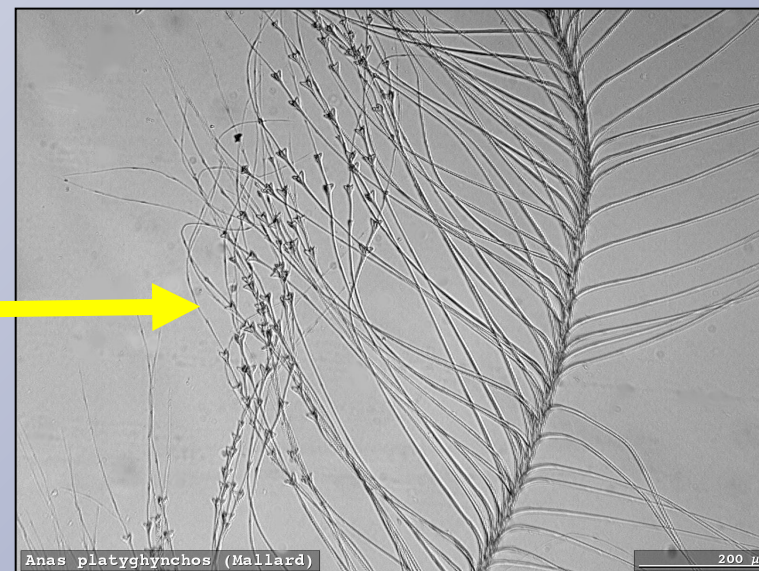
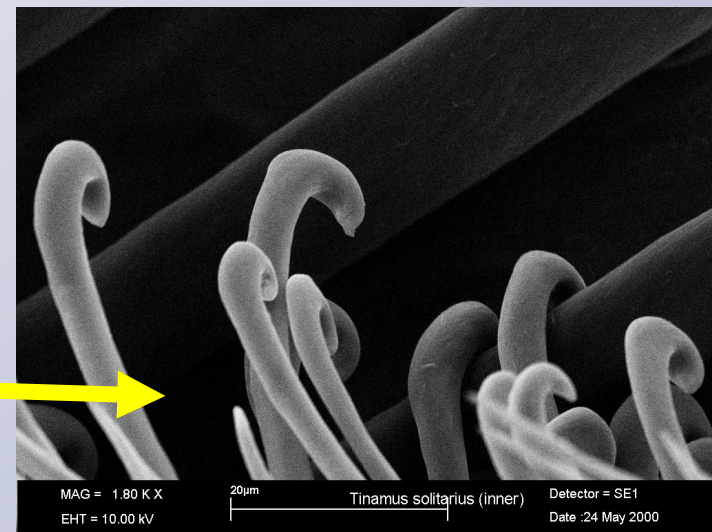
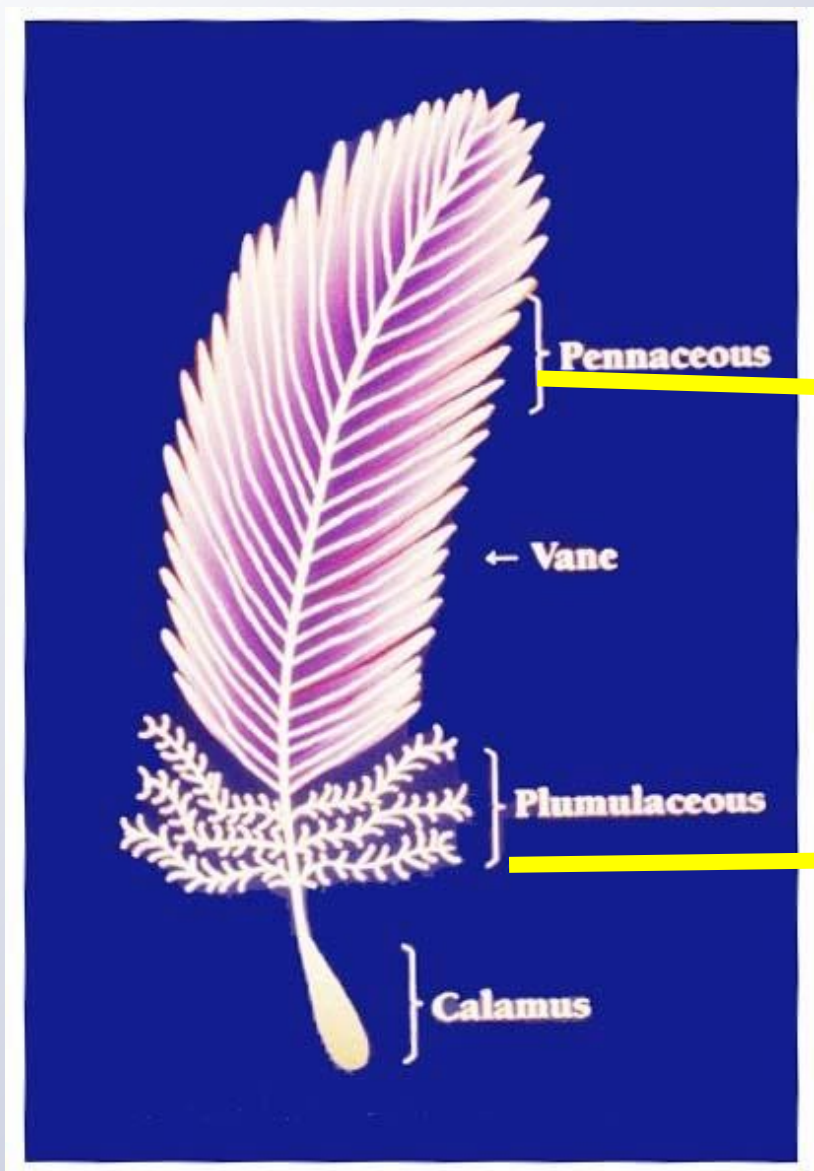


© Marie Read

FEATHER IDENTIFICATION -Microscopic Analysis



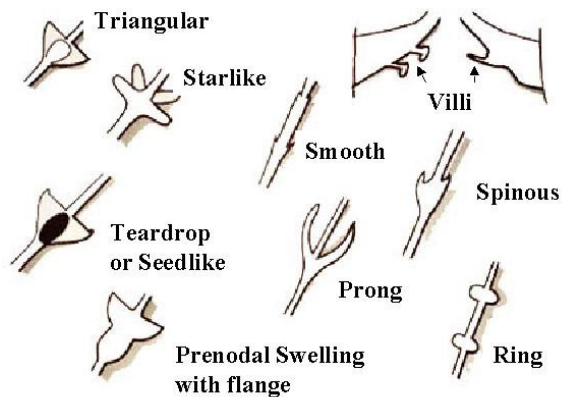
FEATHER IDENTIFICATION -Microscopic Analysis



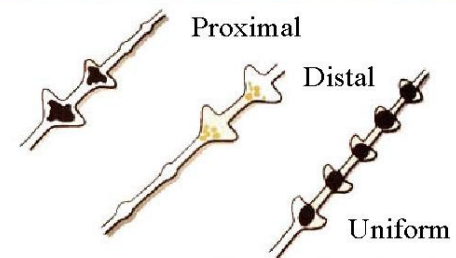
FEATHER IDENTIFICATION - Microscopic Analysis



Types of NODAL STRUCTURES

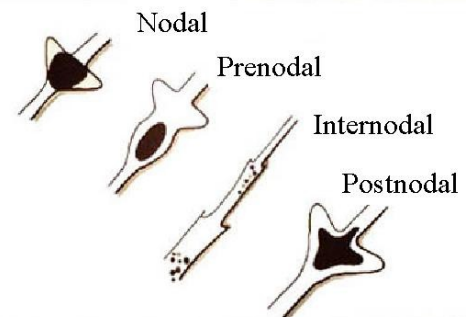


LOCATION OF NODES

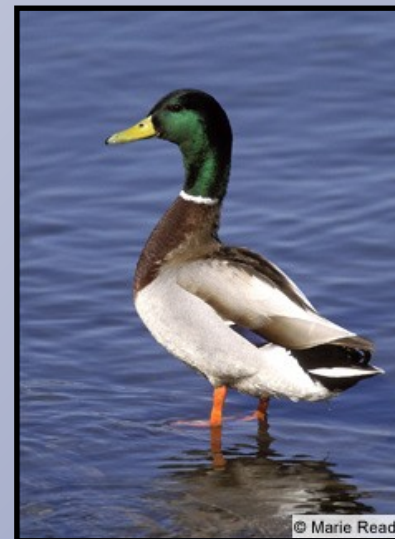
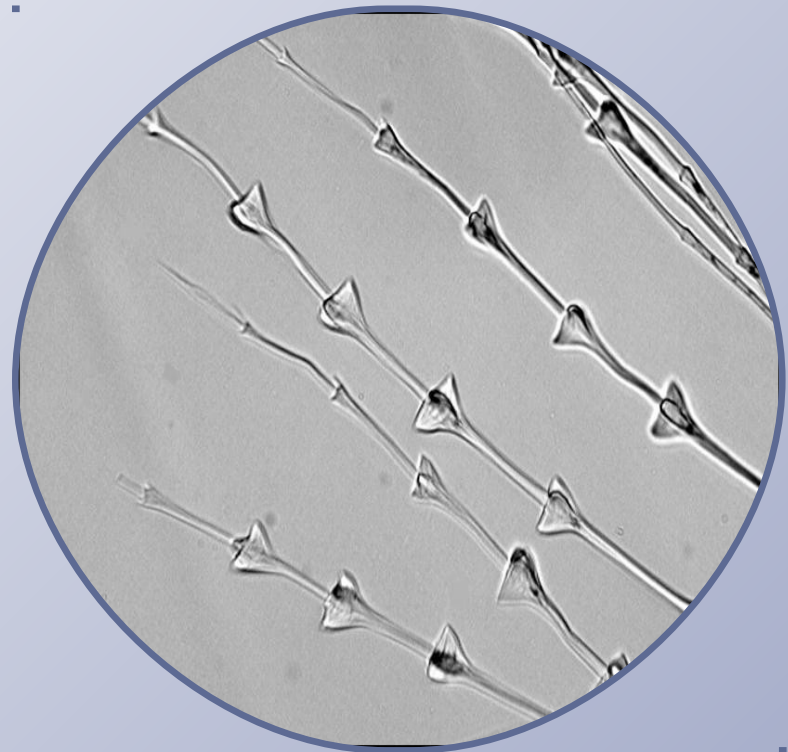
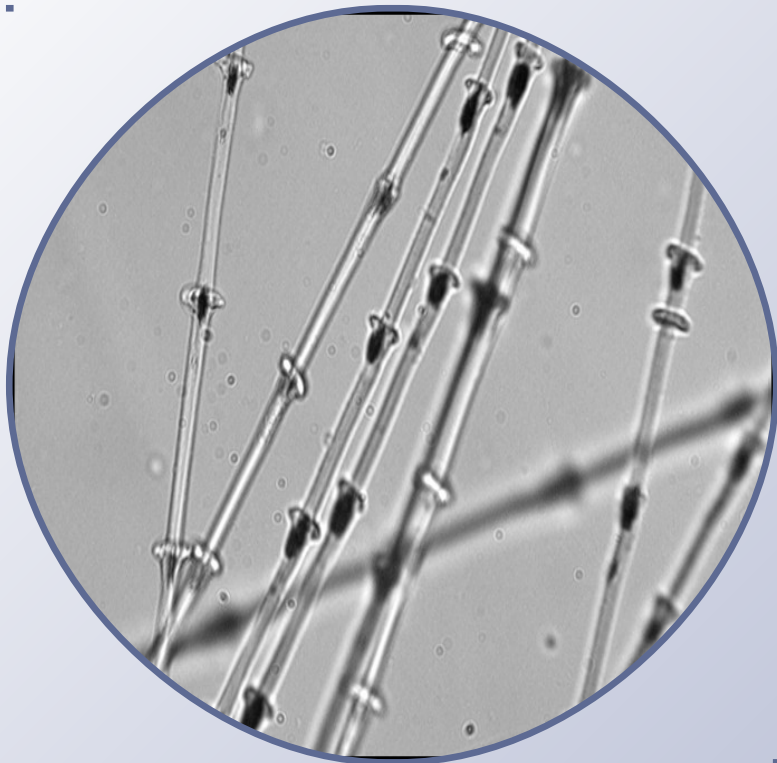


Different Types of Nodal Structures may exist on same Downy Barbs.

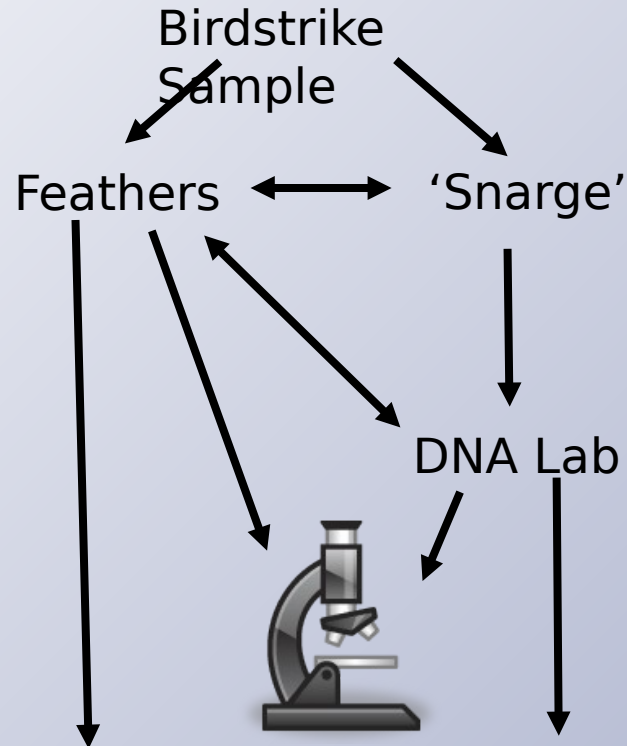
PIGMENT DISTRIBUTION



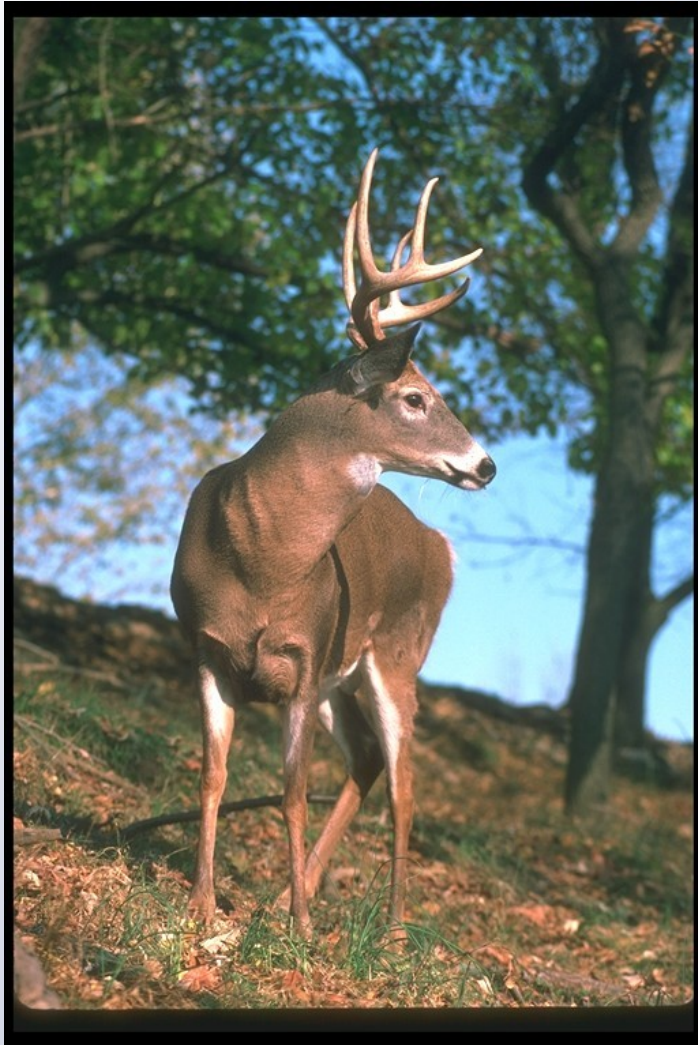
FEATHER IDENTIFICATION - Microscopic Analysis



FEATHER IDENTIFICATION TOOLBOX



Species Identification



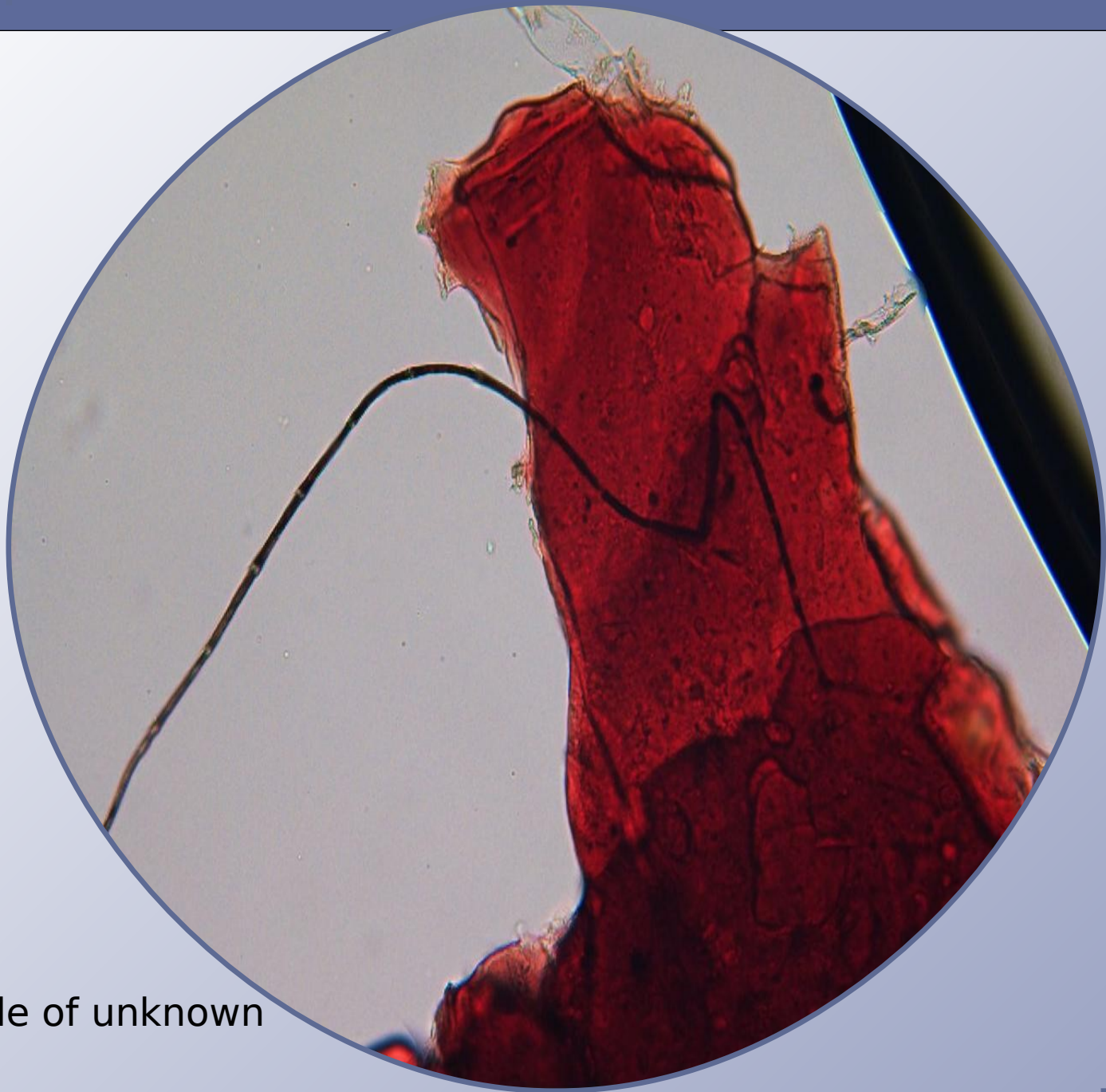
14 January 2008, Randolph AFB

Damage = \$8,000

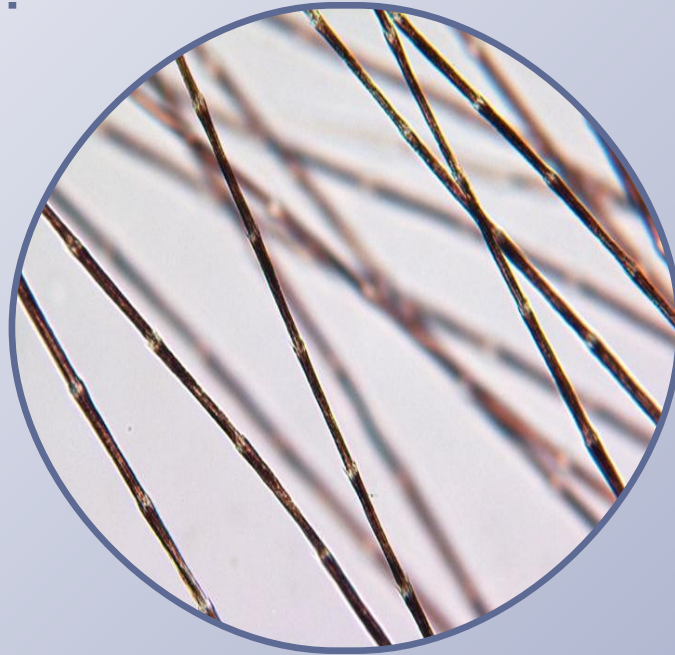
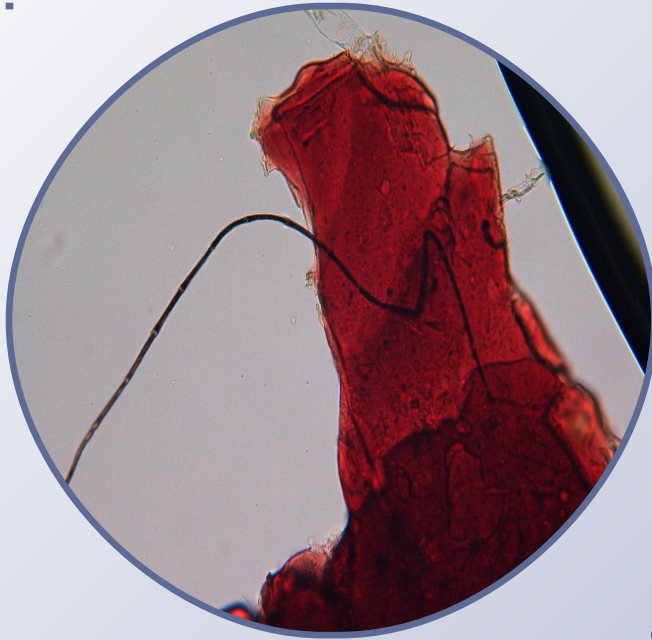
Altitude = 1,500'

Impact point: wing





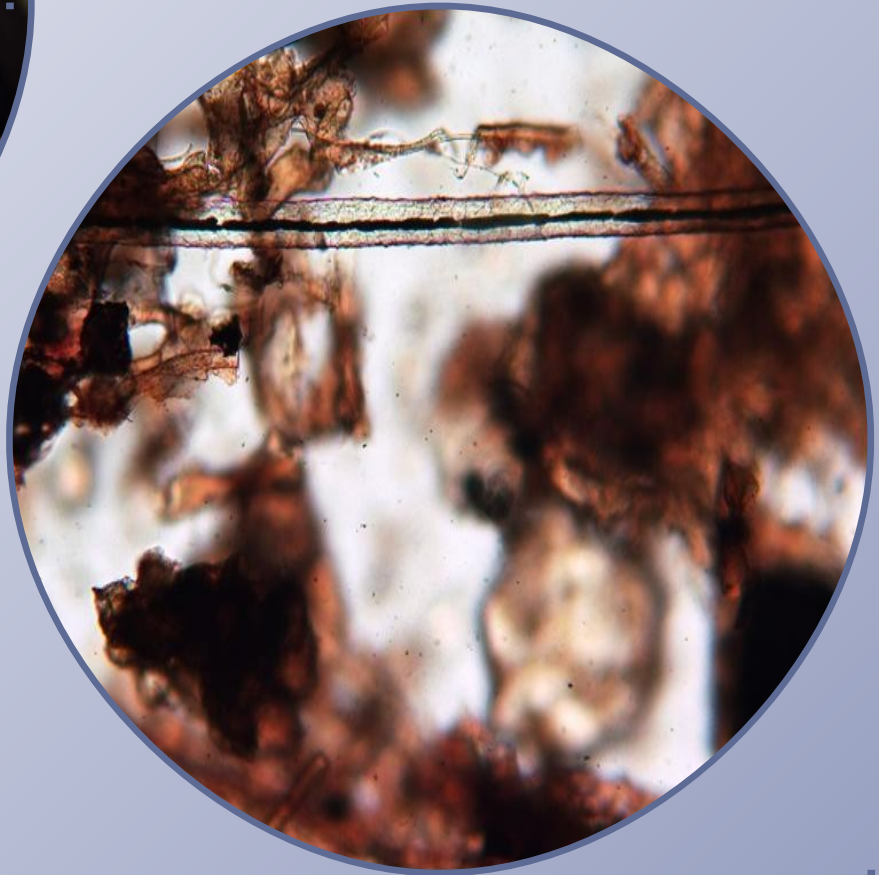
Microslide of unknown
sample



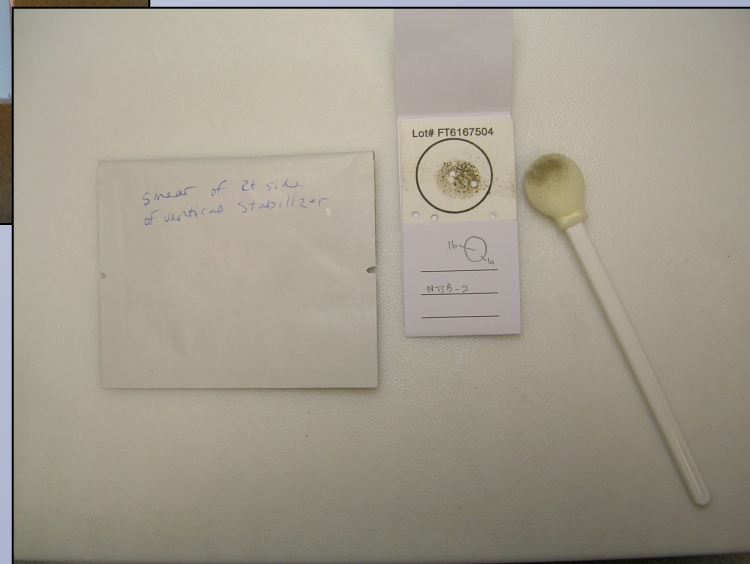
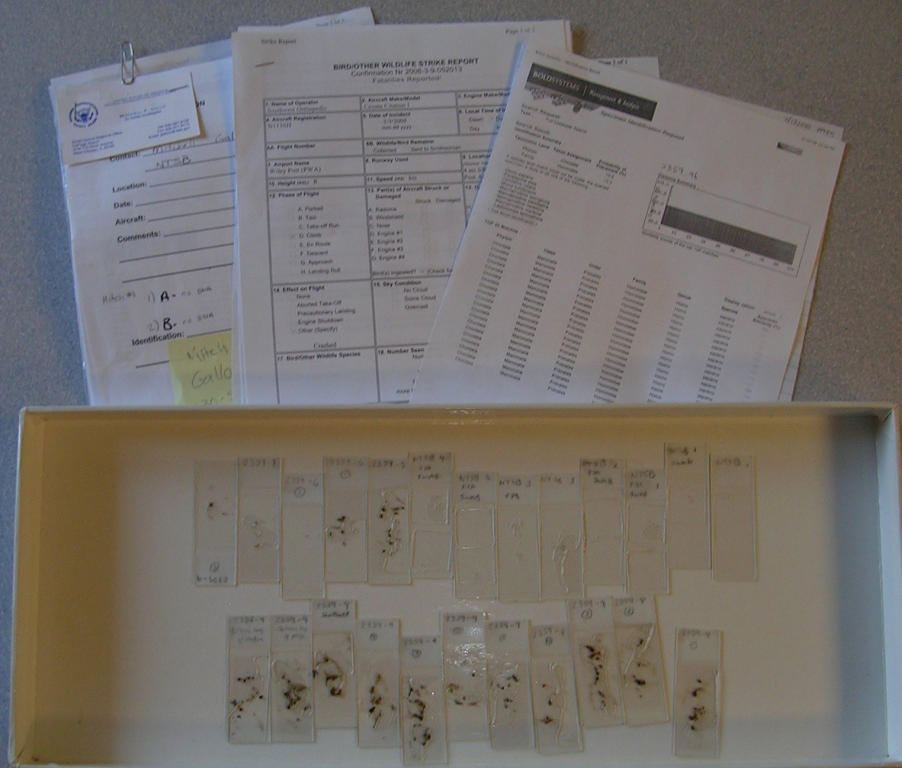


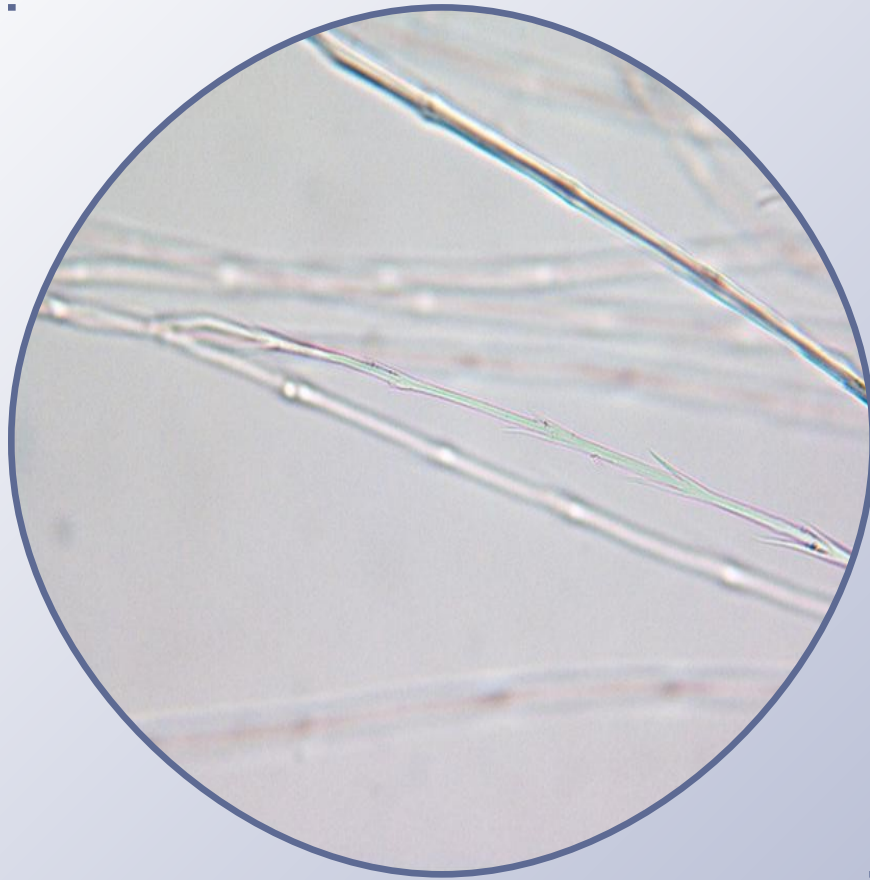




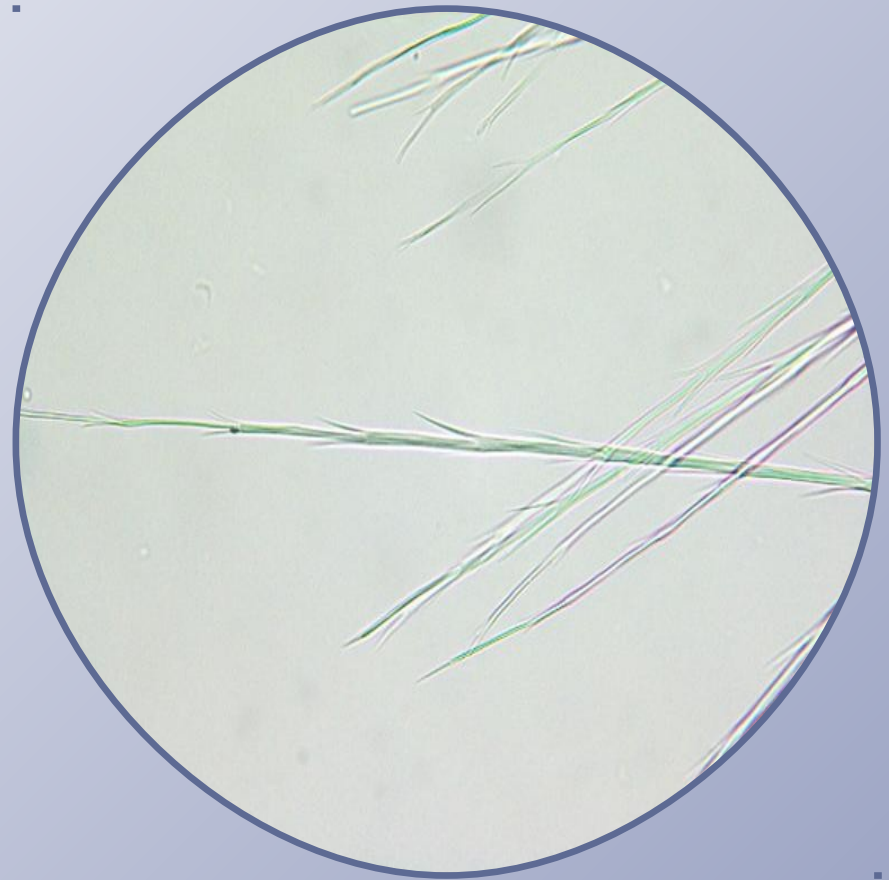








Unknown sample



Reference sample

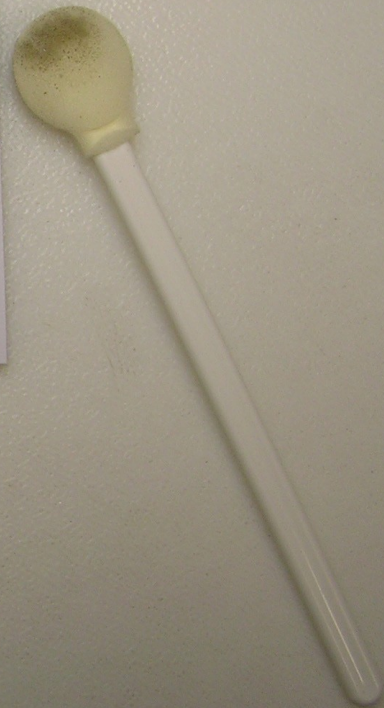
Smear of Rt side
of vertical stabilizer

Lot# FT6167504

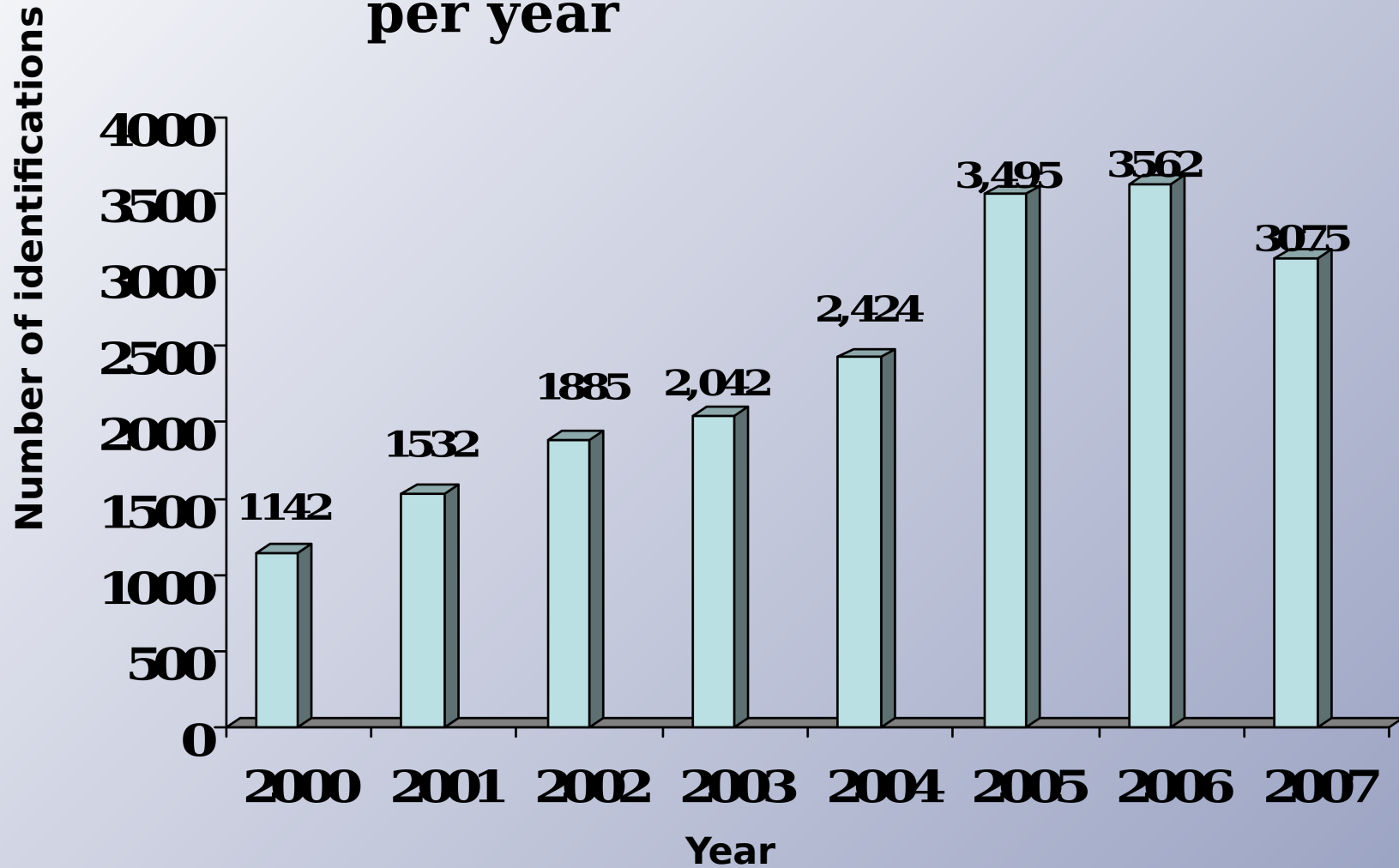


1b-Q_{1a}

NTSB-2



Number of USAF Identifications per year



➤ 36 species of birds in North America exceed the 4 pound FAA weight standard established for airworthiness of airframes and windshields

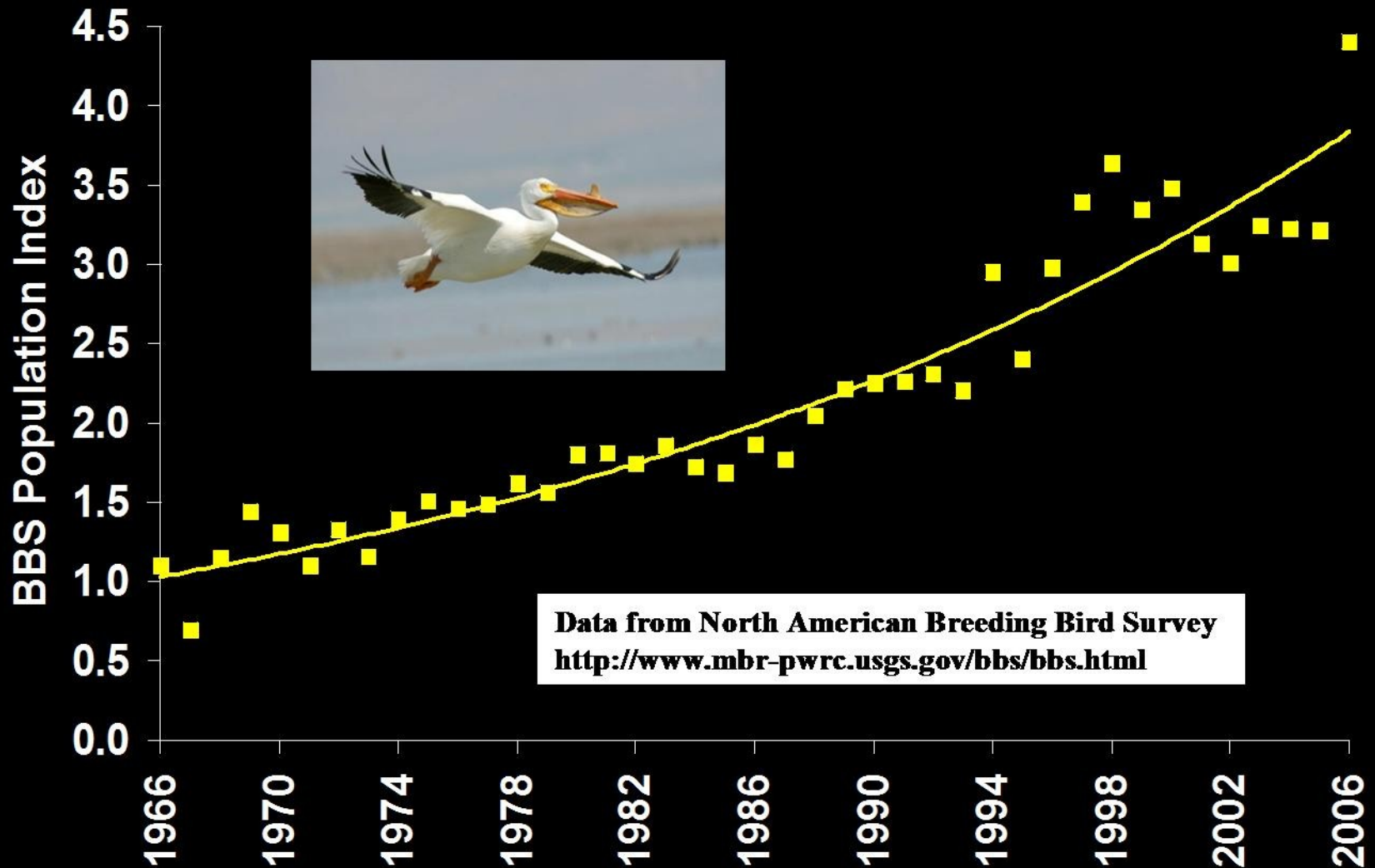
➤ 13 of the 14 bird species in North America with mean body masses greater than 8 pounds have shown significant population increases over the past three decades



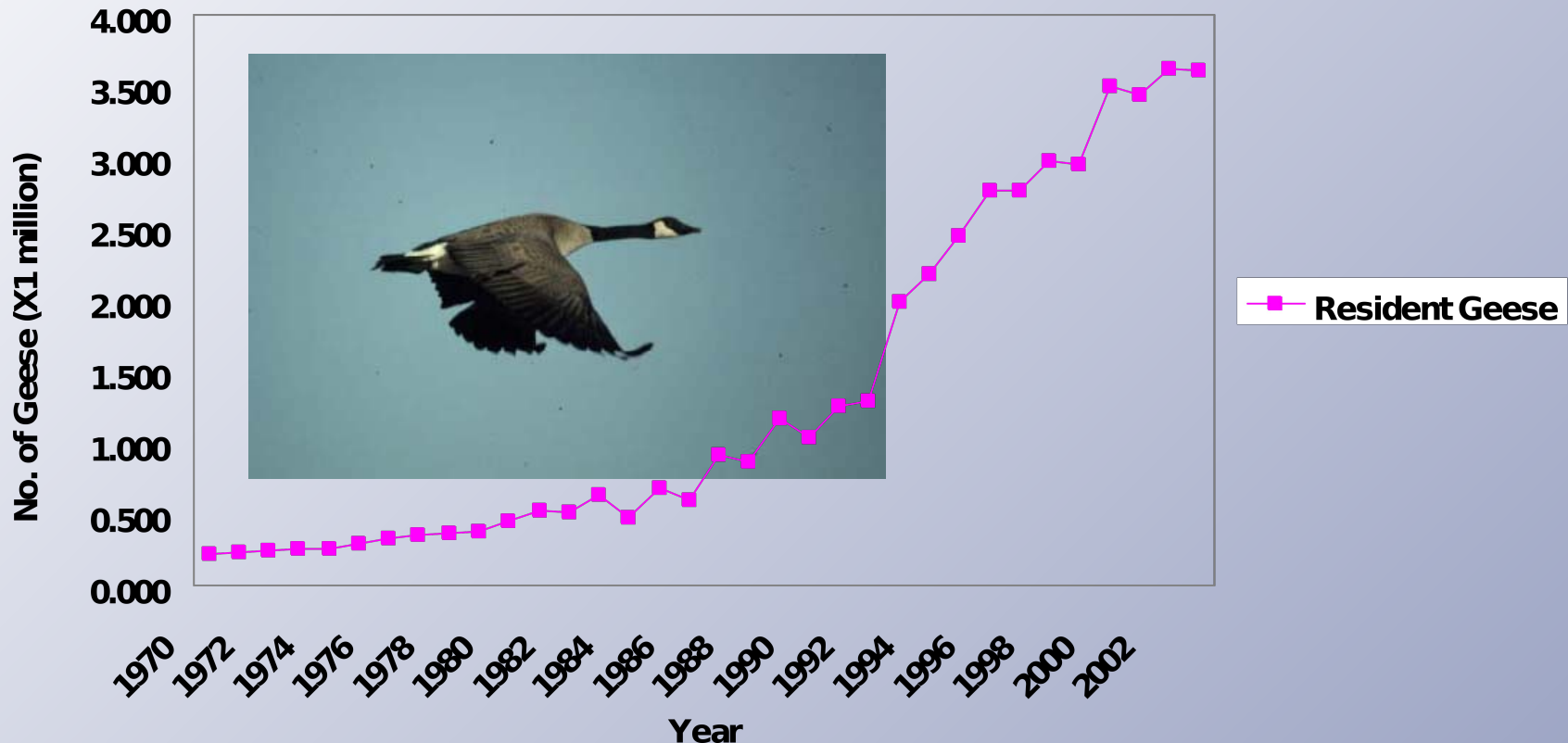
(c) George Jameson



Breeding population of white pelicans has increased at a mean annual rate of 4.3% in North America, 1966-2006



RESIDENT (NON-MIGRATORY) CANADA GOOSE POPULATION IN NORTH AMERICA INCREASED FROM 1 MILLION IN 1990 TO 3.6 MILLION IN 2003



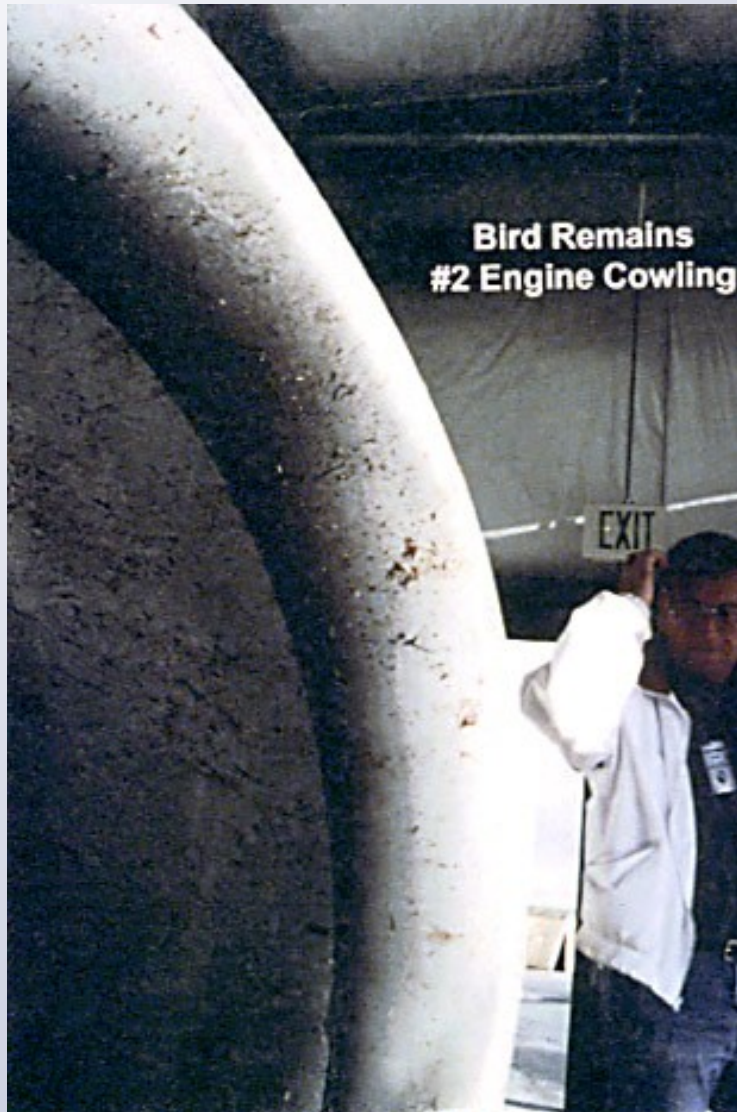
(Source U.S. Fish and Wildlife
Service)



Elmendorf Air Force Base, Alaska
22 Sept 1995



USAF Canada Goose Strikes



	Count	Benchmarks
1993	12	24 strikes
1994	7	
1995	5	
1996	2	8 strikes
1997	0	
1998	6	
1999	4	
2000	5	
2001	6	
2002	2	
2003	1	
2004	2	
2005	2	33 strikes 1996-2006
2006	3	

Feather Lab Support:

- U.S. Air Force, HQ AFSC
Bird Aircraft Strike Hazard
Program

- U.S. Department of
Transportation - Federal
Aviation Administration-
William J. Hughes Technical
Center

- U.S. Air National Guard -
Environmental Planning
Branch

- U.S. Department of
Defense (DoD) Legacy
Resource



- Management Program

- Smithsonian Institution -
LAB

*• Special thanks to Capt. Laura Stepko, USAF Safety Center
for assistance with statistical data for this presentation.*

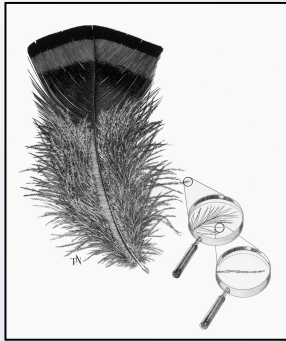
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- Pest Management/bird control on airfields
- USFWS depredation permits
- Information on migration, habitat preference, diet, life history





Questions

dovec@si.edu
202-633-0787



Image courtesy USAF - Flying Safety Magazine

